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Lewis Research Center



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PRODUCTION OF SMALL DIAMETER HIGH-TEMPERATURE-STRENGTH REFRACTORY METAL WIRES

Small refractory metal alloy wires are of interest for manufacturing fiber-reinforced superalloy (nickel base and cobalt base alloy) composite materials. Such fiber-reinforced composites are useful because they exhibit high strength at high temperatures. Superalloy composites reinforced with refractory metal wires have demonstrated superior properties compared to conventional (un-reinforced) superalloys at such high temperatures. These composite materials derive their high temperature strength from the superior properties of the reinforcing wires; thus, refractory metal alloy wires in long continuous lengths are needed. However, it is difficult to fabricate fine wires from these refractory alloys because of their high strength.

Fabrication procedures have recently been developed for producing small diameter wire from three refractory metal alloys: a tantalum base alloy (0.027C-1Hf-1Re-8W-balance Ta), a columbium base alloy (0.06C-2Hf-28W-balance Cb) and a tungsten base alloy (0.03C-0.35Hf-balance W). With these procedures, continuous lengths of wires varying in diameter from 0.25 to 0.51 mm (0.01 to 0.02 inch) have been produced. The techniques employed in the production of wire are common to the art; however, special thermomechanical techniques (schedules) were applied to the first successful production of fine wire from these alloys.

The tensile and stress-rupture properties of these wires (as compared to some conventional materials) are as follows:

<u>Refractory Wire</u>	<u>Tensile Strength at 1366 K (2000° F)</u>
Tungsten base alloy	1430 MN/m ² (207,000 psi)
(compared to conventional tungsten lamp filament)	(862 MN/m ² (125,000 psi))
Tantalum base alloy	779 MN/m ² (113,000 psi)
Columbium base alloy	530 MN/m ² (77,000 psi)
<u>Refractory Wire</u>	<u>100 Hour Stress-Rupture Strength at 1366 K (2000° F)</u>
Tungsten base alloy	1110 MN/m ² (161,000 psi)
(compared to conventional tungsten lamp filament)	(379 MN/m ² (55,000 psi))
Tantalum base alloy	590 MN/m ² (85,000 psi)
Columbium base alloy	350 MN/m ² (50,000 psi)

(continued overleaf)

The high strengths of these wires indicate their potential for contributing increased strength to metallic composites. For example, it may be possible to produce tungsten alloy wire reinforced superalloys with over three times the tensile strength and up to ten times the 1000-hour rupture-strength at 1366 K (2000°F) of the strongest unreinforced superalloys. Such a composite could be used in hollow turbine blades for operating temperatures in the 1366 to 1477 K (2000 to 2200°F) range.

NOTES:

1. The tantalum base and columbium base alloys were developed under government contracts by Westinghouse Astronuclear Laboratories and are designated as ASTAR-811C and B-88, respectively. The tungsten base alloy designated W-Hf-C was developed by NASA.
2. The following documentation may be obtained from:
National Technical Information Service
Springfield, Virginia 22151
(microfiche \$0.95)

Reference: NASA TN-D-6881 (N72-29561), High-Temperature Strength of Refractory-Metal Wires and Consideration for Composite Application; Single document price \$3.00

Reference: NASA CR-120925 (N72-26399), Development of Wire Drawing Processes for Refractory Metal Fibers; Single document price \$5.50

3. A brief supplementary report entitled "Development of Wire Drawing Processes for Refractory Metal Fibers" can be obtained from:

Technology Utilization Officer
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
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PATENT STATUS:

NASA has decided not to apply for a patent.

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G.W. King
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